



Exploration & **SPACE**  
Communications

*More than you ever imagined...*

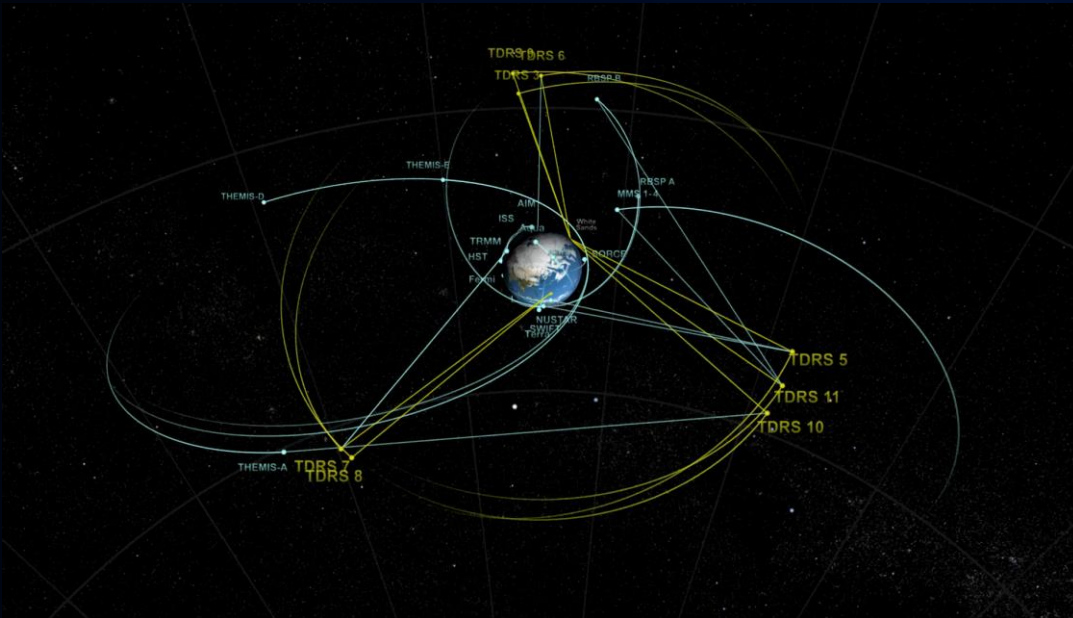
Providing a Service that Doubles the  
International Space Station Science Data Return





# The Space Network

- The Space Network pairs ground stations with NASA's **Tracking and Data Relay Satellite** (TDRS) fleet to provide continuous radio communications coverage to spacecraft in low-Earth orbit, including the **International Space Station**
- The Space Network uses **radio frequency** to transmit this data



- There are **10 active** TDRS in orbit, at an altitude of 22,000 miles
- Data collected on user spacecraft is sent to a TDRS, which then **downlinks** the data to ground stations on Earth





# The International Space Station

The International Space Station is an inhabitable laboratory orbiting 250 miles above Earth. Home to a number of international astronauts, conducting science experiments and spacewalks. The space station requires a robust communications network to support onboard activities. The space station utilizes NASA's Space Network, a constellation of relay satellites using radio frequency to transmit data down to the Earth. The team worked to increase communications capabilities. The Space Communications and Navigation program office assigns the management of the Space Network to NASA's Goddard Space Flight Center in Greenbelt, Maryland. The International Space Station Program Office is located in Houston, Texas at NASA's Johnson Space Station.



# NASA's Communications Networks – Video



# The Initiative

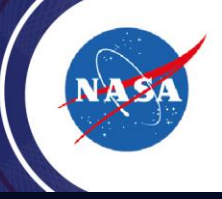


The team responsible for doubling the data rate on the International Space Station accomplished this with a significant number of women in leadership roles over a three-year period, and this will be fully operational in May 2019.

They increased space station data rates using improved technology to achieve 600 Mbps with fewer communications interruptions.

The higher data rates provide for stronger communications with mission control, increasing astronaut safety; reliable connections to Earth, including conversations with family; and larger science data return, enabling new discoveries.

# The Team



**Teams from two NASA centers worked together to increase the International Space Station's data rates.**

## Goddard Space Flight Center:

- Space Network Team Located at White Sands, New Mexico, and Greenbelt, Maryland
- Communications Services Office Team
- Peraton: Space Network Development and Operations Contractor

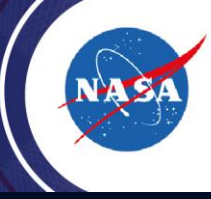
## Johnson Space Center:

- Flight Operations Directorate Ground Segment and Operations Teams
- Engineering Directorate's Communications and Tracking System Team
- The Boeing Company: International Space Station Sustaining Engineering Contractor





# Women in Charge



**The Initiative for Doubling the Science Data Return for the International Space Station had numerous women in leadership role, including:**

Nominees	Role	Center/Employer	Detail
Risha George	Space Network Project Lead	GSFC/NASA	Functioned at the liaison between GSFC and JSC
Haleh Safavi	Radio Frequency Communications Lead Engineer	GSFC/NASA	Digital Architecture Integration into the Space Network Infrastructure Lead at GSFC
Penny Roberts	International Space Station Project Lead	JSC/NASA	Lead activities at JSC to make change to International Space Station
Sharon Marston	Electronic Systems Test Laboratory Lead	JSC/NASA	Responsible for conducting system tests to ensure functionality of new communication capabilities
Haley Boose	Radio Frequency Analysis Lead	JSC/NASA	Conducted end-to-end communications analysis to ensure operational functionality
Rita Carlson	Flight Software Transition Lead	JSC/SGT	Ensured the integrity of the flight software and oversaw installation on the International Space Station
Donna Maddi	El Segundo Project Manager	The Boeing Company	Oversaw the modem firmware upgrade



# The Team





# The Effort



The International Space Station, designed in the 90s, was initially able to transmit data at 150 Mbps.

## To achieve the upgrade the team had to:

- Enhance Space Network ground stations, located in Guam and at NASA's White Sands Complex
- Update space station data processors throughout NASA to enable 600 Mbps of data flow
- Modify the onboard Ku-band modem's modulation and forward error correction algorithms
- Update the integrated communications unit software to process twice as much data (ingesting, recording and downlinking)
- Modify the vehicle to establish a 1 Gig interface to the Joint Station Local Area Network



**White Sands Ground Terminal**



**International Space Station**



**Guam Remote Ground Terminal**



# The Projects Involved



## **The initiative involved a number of sub-projects:**

Ku-band Transition Project Team

Enhanced Digital Infrastructure for the Space Network Team

Safety and Mission Assurance Team

ICU Flight Software Team

Command and Tracking Team

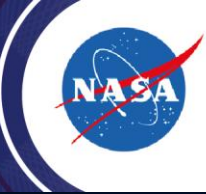
Electronic Systems Test Laboratory Team

Human System Integration Team

Mission Control Center Team



# The Impact



This initiative enables more research to occur on the International Space Station by **doubling the data rate** to the ground and increasing communications coverage to as much as **95 percent of the orbit**.

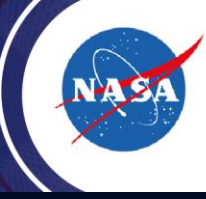
Space station research includes human research, biology, biotechnology, physical science, earth and space science investigations and technology development and demonstrations as well as educational competitions and demonstrations.

The space station's international partnership includes **15 nations**. This expansion of data rates and coverage supports researchers throughout the world.





# The Benefits



**300 Mbps**



**600 Mbps**

**=**

**EXPERIMENT OPPORTUNITIES**



# The Benefits



**300 Mbps**



**600 Mbps**

**=**

## **ASTRONAUT COMMUNICATIONS**

Communicating on Spacewalks



Talking to Mission Control

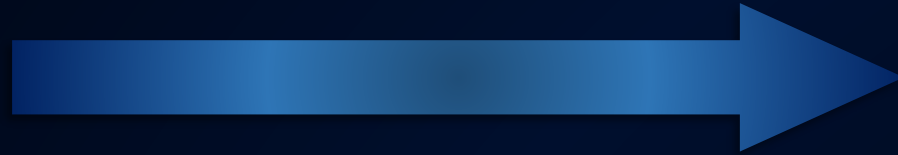




# The Benefits



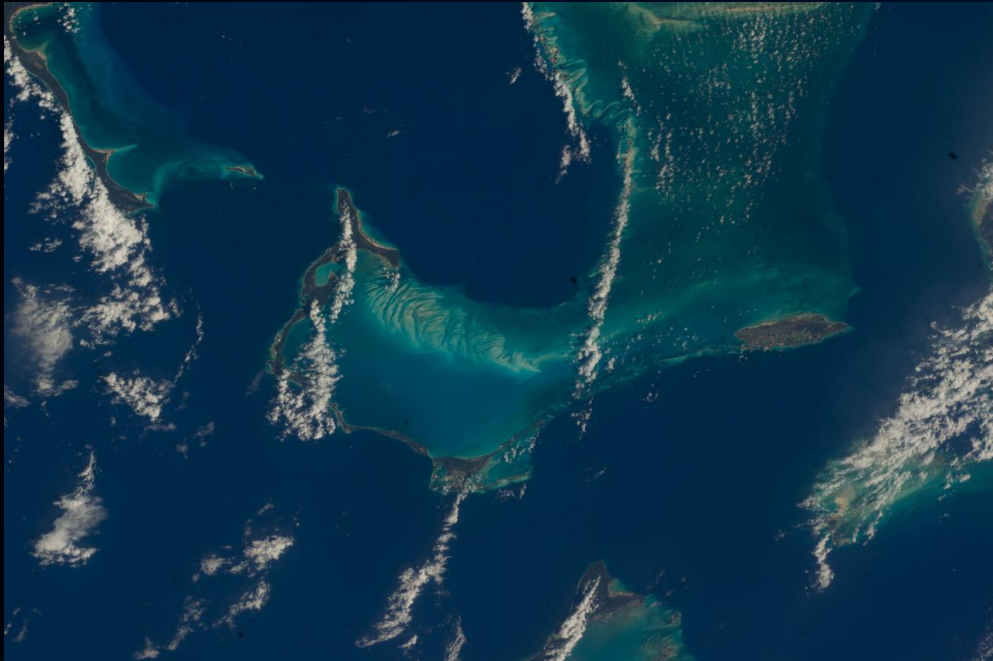
**300 Mbps**



**600 Mbps**

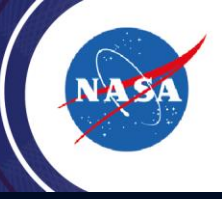
**=**

**MORE SCIENCE DATA**



Images Captured from International Space Station

# Scalability and Reproducibility



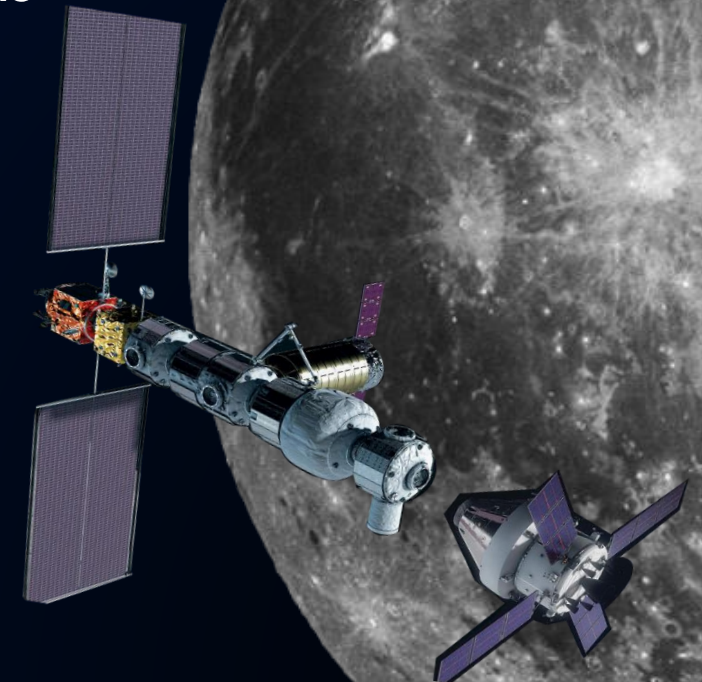
## The ISS upgrade impacts industry and NASA Missions



“RT logic was proud to be called upon to help on this upgrade for the space station. this was significant for us because it gave us the opportunity to partner with NASA and deliver new technology for waveforms and digital signal processing.”

– **Chris Badgett, RT Logic**

NASA's future Gateway, orbiting the Moon, will be similar to the space station but in the lunar region and will take advantage of this capability





# Recognition



*“Goddard’s communications networks play a pivotal role in every NASA mission, enabling data from human spaceflight, space and Earth science research missions and technological demonstrations to reach Earth for the benefit of humanity. This increase in-data rate capability for the International Space Station underlines our commitment to provide high-quality operational services for NASA exploration missions today and in the future.”*

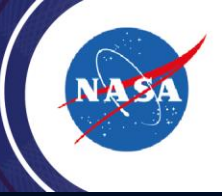
**– George Morrow, GSFC Deputy Center Director**

*As a US Astronaut flying on Space Shuttle Mission STS-102 responsible for assembling the ISS, I’d like to emphasize the importance of the doubling of the speed of the science data this international laboratory produces. Not only does it enable more and higher fidelity research, it provides a valuable tool for astronauts as they can conduct experiments more efficiently. This capability also helps the astronauts maintain a productive interface with mission controllers and a healthy interface with their family members as they spend months away from them. I’d also like to recognize the strong level of leadership by some of our agencies best and brightest women that brought this enhancement to fruition. As the father of a daughter entering a STEM field I am pleased to see the level of encouragement and support these women from received from NASA in accomplishing this achievement. Job well done!”*

**Paul Richards, USA Astronaut/Technology Evolution Manager at NASA GSFC**



# Recognition

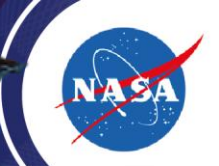


*In today's highly data rate reliant environment, the thirst for knowledge and data driven solutions that can improve our life on Earth and human exploration well beyond low Earth orbit exists now more than ever. The successful implementation of the ISS 600 Mbps Upgrade Project provides an incredible opportunity to advance science in the world wide community. Among many other goals, the ISS partner agencies share a common goal in "educating the children of today to be the leaders and space explorers of tomorrow". The increased ISS data rate allows more complex experiments to be developed by our children through Science, Technology, Engineering and Math (STEM) educational projects and organizations, including the SciGirls in Space who were recently awarded a \$750K grant for new season of PBS' "SciGirls" episodes and role model videos focusing on girls' space-flown experiments. The ISS Upgrade is an example of a highly motivated team applying advanced technology and innovative solutions that can enable significant opportunities for discovery to our worldwide community.*

**- Ronna Kirchoff, Peraton Space Communications and Navigation Services Program Manager**



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